International R&D partnerships: the role of government funding in reducing transaction costs and opportunistic behavior

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Abstract

The innovation management and policy literature suggests that government support generally has a positive effect on SMEs' R&D, innovation performance, and fostering international links. However, research in this field has mainly examined the outcomes, overlooking the impact during the course of the R&D partnership, especially in an international context. Using longitudinal data and a transaction cost (TC) approach, we conduct an in-depth case study of a UK-China innovation program aimed at supporting and facilitating R&D partnerships between UK SMEs and Chinese organizations. Examining 11 UK SMEs with 12 R&D partnerships in this program, we identify four stages of the R&D partnership with Chinese organizations,

revealing that government support both positively and negatively affects TCs at each stage. Based on these positive and negative effects, we offer empirical and theoretical contributions, as well as managerial and policy implications to support international R&D partnerships.

Keywords: R&D partnership, innovation, internationalization, SME, China, government support.

1. Introduction

Collaboration has always been an important element of innovation strategies (Kleinknecht and Reijnen, 1992). Recent trends in the global economy have pushed firms to partner with foreign organizations for their R&D and innovation activities to adapt their products to local markets, for example. This is particularly true for SMEs that traditionally have fewer resources than large firms, and thus need to develop collaborative strategies to bridge their financial or knowledge gaps (Lu and Beamish, 2006).

Despite offering clear advantages, partnering for R&D also entails risks and additional costs deriving from partner selection (Li et al., 2008), knowledge leakage (Sampson, 2004), uncertain outcomes (Bunduchi, 2013), or intellectual property development and appropriability (Henttonen et al., 2016). Traditionally indicated as transaction costs (TCs), these tend to be higher in international R&D alliances (Li et al., 2013), given the complications resulting from institutional and cultural differences. Contrary to the literature, Hottenrott and Lopes-Bento (2016) suggest that these effects are less pronounced in SMEs, as they often rely on (unions of) government support schemes to leverage resources through external collaborations (e.g. the European Union). These schemes can in fact help them achieve results otherwise beyond their reach.

Although extensive knowledge is available on who, why, and how R&D alliances are formed, as well as evidence on the positive impact of government funding on R&D

partnerships, scholars have yet to investigate the impact of government support on the international R&D alliance process. We argue that prior studies, mostly quantitative and focusing on the R&D alliance creation outcome (Schilling, 2009), have overlooked an important issue by not considering the establishment dynamics that may or may not determine the success or failure of an international R&D partnership under a government-funded support scheme. In this study, we therefore aim to develop a better understanding of how government funding impacts the different stages of the international R&D partnership process.

Adopting a TC perspective, we qualitatively explore the case of a UK-China Innovation Program called Lancaster China Catalyst Programme (LCCP) funded by the UK and Chinese governments, and run by Lancaster University (LU) between 2014 and 2018, aiming to support R&D partnerships between UK SMEs and Chinese organizations. While UK funding was administered through LCCP, additional Chinese government funding was made available on application. Our analysis focuses on these two sequential funding streams and the impact on each stage of the UK-China partnership process.

This paper contributes to existing theory in a number of ways. First, it enriches current understanding of the R&D partnership process by stages, including an international dimension that determines a higher risk of opportunistic behavior in interdependent funding schemes. Second, building on the differentiation between institutional and administrative TCs (Williamson, 1985), and monitoring mechanisms (Tripsas et al., 1995), this study contributes to a better understanding of the impact of these mechanisms on the *ex-ante* and *ex-post* stages of the R&D partnership and the interplay dynamics between two funding streams. Third, we identify a novel negative role of public funding, potentially leading to a higher risk of opportunistic behavior in international R&D partnerships.

The remainder of the paper is organized as follows: Section 2 provides a literature review and the theoretical framework. Section 3 introduces the research setting, data, and methodology

used. The findings are presented in Section 4, followed by a discussion in Section 5. Section 6 concludes by highlighting the contributions and implications.

2. Literature review and theoretical framework

2.1. SMEs, alliances, and government funding

Extensive studies show that SMEs often lack the resources to compete on two important dimensions: internationalization and innovation (De Massis et al., 2018; Lu and Beamish, 2006). They lack the capabilities and assets that allow them to enter a foreign market, and more importantly, the R&D resources that would allow them to innovate and be competitive in these markets. Alliances provide a possible solution, as they provide a means to market entry (Dunning, 1995), and access to technology (Narula and Dunning, 1998) as innovation facilitators (Chesbrough, 2003). However, the establishment and progression of an alliance is still a challenge for most firms and for SMEs specifically. Several studies have looked into the formation stages of alliances, pointing out the challenges that the participating firms face at each stage (Hoffmann and Schlosser, 2001; Swoboda et al., 2011). In addition, while SMEs can seemingly leverage alliances to improve their innovation capabilities and enter a foreign market, they are also prone to appropriability due to their limited resources (Colombo and Piva, 2019). The appropriability hazard may be even more pronounced in the international setting, as SMEs lack resources to tackle the unfamiliarity and information asymmetry of a foreign market.

Given the substantial challenges that SMEs face (Mukherjee et al., 2013), public support in forming alliances is commonly provided by governments (Bellucci et al., 2019) in different forms (Narula and Dunning, 1998).

This phenomenon has inspired scholars to further investigate the role of government support in the creation and success of R&D alliances and joint R&D projects (Broekel et al., 2015) to identify potential cooperation additionality (Wanzenböck et al., 2013), showing an overall

positive effect of government funding on SME R&D alliances (Bellucci et al., 2019; Radicic et al., 2020). Hottenrott and Lopes-Bento (2014) find that the positive effect of public support on R&D activities is stronger in SMEs collaborating internationally, resulting in investing more of their own funds in R&D, in turn launching a higher number of product/market innovations. Several studies show that R&D subsidies increase the likelihood of firms establishing R&D partnerships with public research organizations and other private firms (Busom and Fernández-Ribas, 2008; Afcha Chávez, 2011). As government support is generally found to have positive effects on R&D collaborations, some studies have investigated the attributes that make projects more likely to receive R&D subsidies (Feldman and Kelley, 2006), and the motivations for firms to enter into R&D partnerships (Bayona et al., 2001). While access to government grants is one such motivation (Arranz et al., 2016), the causal relationship between government support and the formation of R&D collaborations is unclear.

We argue that prior literature has neglected an important aspect by not looking into the creation and progress dynamics that determine the success or failure of international R&D partnerships under government funded schemes. We therefore aim to develop a better understanding of how government support impacts the different stages of international R&D partnerships.

2.2 Transaction costs and R&D partnerships

In this study, we adopt a transaction cost (TC) approach. TC economics (TCE) is widely used to study the risks and costs incurred in R&D partnerships arising from opportunistic behavior as the antecedents and outcomes of alliances (Judge and Dooley, 2006). According to TCE, alliances entail coordination and monitoring costs that vary according to certain conditions that define the transactions between the parties: asset specificity, uncertainty, information asymmetry, and transaction frequency (Osborn and Baughn, 1990). High levels of these

conditions lead to the greater risk of opportunistic behavior between the parties, as well as increasing TCs and the likelihood of alliance failure.

TCE in alliances has mostly dealt with organizational choices along the typical market vs hierarchy continuum (Oxley and Sampson, 2004). Scholars have also looked at the mechanisms through which firms can reduce opportunistic behavior in alliances. We here build on a less developed subset of this literature that focuses on the role of government in reducing TCs in alliances through monetary and non-monetary mechanisms (Tripsas et al., 1995; Kim et al., 2014; Nishimura and Okamuro, 2016). Government funding through monetary mechanisms is often provided as direct grants or subsidies to organizations that seek to establish alliances with external partners. Alternatively, some studies provide evidence of how governments might play an active role in reducing the risk of opportunistic behavior in R&D alliances through non-monetary mechanisms (Tripsas et al., 1995; De Mattos et al., 2013) by, for example, establishing a solid and precise legal framework for the parties, and/or monitoring and enforcing compliance under such framework. While they point out that public funding in the form of direct grants or subsidies is an important means of facilitating collaborative innovation, they also highlight the reduction of TCs achieved through mechanisms that differ from monetary help for alliances (Okamuro and Nishimura, 2011; Kim et al., 2014), such as government-coordinated R&D consortia or platforms. Government-promoted collaborative platforms can create an environment where parties are more willing to share information, resulting in reduced information asymmetry and increased trust (Tripsas et al., 1995).

Building on Williamson's (1985) distinction between *ex-ante* (prior to the establishment of a partnership) and *ex-post* (after the establishment) TCs, Tripsas et al. (1995) distinguish between institutional and administrative mechanisms as "measures available to government that may help to discourage opportunistic behavior". A government's use of institutional mechanisms helps establish a framework within which collaboration occurs. This in turn

reduces the costs of, for example, negotiating and drafting contracts by setting clear boundaries within which they are drafted, thus reducing the negotiation space. As such, these mechanisms are particularly useful to reduce uncertainty and information asymmetry in the initial phases of the collaboration. Administrative mechanisms are instead typically used by governments to monitor and enforce the execution of contracts as established (or renegotiated) in the *ex-ante* phase. As such, governments tend to have a more active and interventionist role in running the collaborative partnerships (e.g., through governance bodies) during the *ex-post* phase (see Figure 1).

Building on this approach, we investigate how different forms of government funding might reduce opportunistic behavior (and therefore TCs) in the different stages of an international R&D partnership lifecycle relying on non-monetary institutional and administrative mechanisms.

(Insert Figure 1 about here)

3. Context and methodology

3.1. Empirical setting

Given the exploratory nature of this study, we adopt a longitudinal comparative case study approach (Yin, 2017) to analyze 11 UK SMEs that fully participated in the first two-year cycle (2014–2016) of the three-cycle LCCP (Table 1) where 9 of the 11 SMEs formed a total 12 R&D partnerships while the other 2 did not. Their journey is depicted in Figure 2.

A case study approach is particularly suitable to study the R&D partnerships formed by organizations from two different countries, receiving support from both governments (Welch et al., 2011), and analysing changes that occur throughout the process (Brown and Eisenhardt, 1997).

LCCP was a business support program ideated and run by LU between 2014 and 2018 with a total three cycles aimed at supporting the creation and development of R&D partnerships

between UK SMEs and Chinese organizations for the purpose of creating new or modifying existing products/services. The program was funded by the Higher Education Founding Council of England (HEFCE) and the Lancashire County Council in the UK, and had its main Chinese supporting partner in the Guangdong Department of Science and Technology Department (GDST). LCCP offered a support scheme organized in three stages: *investigate, accelerate,* and *cooperate* (see Figure 1). The program also established a 2-year postgraduate degree where students spent the first year doing coursework and the second year supporting the R&D partnership projects.

In the three stages, GDST released annual calls for applications to fund the most promising UK-China partnerships with up to RMB 1 million.

As China's role as both an international market and global innovation scenario becomes more and more important, it is essential to understand how foreign companies can operate in this environment. The case of UK SMEs is particularly interesting given the renewed search for fertile international markets after the UK left the European Common Market.

(Insert Table 1 and Figure 2 about here)

Among the three LCCP cycles, we chose Cycle 1 as our sample of analysis due to data completeness in tracking changes in the process over time, and to capture constructs that might not appear in subsequent cycles due to the learning curve in running the program (Van de Ven, 2007). In addition to this, Cycle 1 also offered a representative sample of SMEs from different sectors across the UK. This allowed us to avoid selection bias and compare the effect of different funding mechanisms throughout the different stages between the two countries (Klette et al., 2000).

3.2. Data

Data were collected between August 2014 and April 2018 at 3 levels: 1) *institutional*,

consisting of data documenting the program; 2) *firm and project*, consisting of data pertaining to each firm's two-year journey; 3) *student*, consisting of documents related to the students' work on the firms' R&D projects (see Table 2). The data collected derived from both primary and secondary sources. In addition, the authors conducted 20 interviews with the LCCP project leaders of the 11 UK SMEs, complementing participant observation thanks to two of the authors being involved in the program's design and management. The variety of data and sources allowed satisfactory data triangulation, thereby reducing the risk of bias in their interpretation.

(Insert Table 2 about here)

3.3. Data Analysis

Given our interest in understanding the effect of government funding on mitigating opportunistic behavior throughout the lifecycle of an international R&D partnership, the first step of our analysis was to identify the stages of the partnership. Similar to the studies of George and Farris (1999) and Hoffmann and Schlosser (2001), we isolated 4 stages of a common path that the UK SMEs followed in establishing R&D partnerships with Chinese organizations. These stages are *screening, formation, development*, and *continuation*. Taking into account the government support from 2 different countries, we then separated the effect of government support by stage and country. In the first stage – *screening* – the UK SMEs were introduced to potential Chinese partners and had to decide whether to enter into an R&D partnership, which would then qualify them for the second stage – *formation*. If a partnership proceeded with the GDST funding application, it would enter the *development* stage, defining the product/service specification for the purpose of the funding bid. In the final stage – *continuation* – the actual R&D project was undertaken by the R&D partnership.

Adapting Tripsas et al. (1995), we treated the first two stages – *screening* and *formation* – as generating *ex-ante* TCs, controllable via institutional mechanisms, and the second two stages

– *development* and *continuation* – as generating *ex-post* TCs, controllable via administrative mechanisms. Following Dahlman's (1979) interpretation of TCs as "resource losses due to lack of information" (p. 148), we isolated the impact of the identified mechanisms on TCs associated with partnership progress. Specifically, adopting a UK SME perspective, we identified the mechanisms aimed at reducing information asymmetry between the two parties, thereby decreasing the risk of opportunistic behavior for the benefit of the UK party.

4. Findings and analysis

4.1. Screening

The first step in establishing an R&D partnership is finding a potential partner with complementary resources, including technology, finance, and/or market knowledge (Chen, 2004; De Mattos et al., 2013). The 11 firms analyzed were no exception, seeking partners with market knowledge (Firms A, E, I, K), technological know-how (Firms B, F), or both (Firms C, D, G, H, J). Given the international setting and the search for a partner in a foreign country, TCs would mostly be in the form of search costs (Dahlman, 1979) through one main institutional mechanism on both the UK and Chinese side, which we call *contact and network sourcing platform*. The platform set up by LCCP allowed UK SMEs to access networks and contacts otherwise expensive or impossible to reach. Without such a platform, a UK SME would have to explore contacts by itself at high expense and time resources, or rely on private consultants.

Following the compilation of the expression of interest (EOI) form where the UK SMEs specified their search criteria, the LCCP UK and China team would then work with GDST to search for potential partners through their proprietary database of local high-tech organizations. The LCCP China team would then initiate contact with these organizations on behalf of the UK SME. This mechanism is not dissimilar to other government funded initiatives, such as the trade missions organized by the Department for International Trade (DIT) in the UK, differing

only in the fact that the UK government relied on a third party – the university – to administer the funding.

4.2. Formation

In this stage, UK SMEs met their potential partners and selected those they wanted to work with. However, they required more information on their potential partners before reaching an agreement (Dahlman, 1979; Reuer and Ariño, 2002), which was facilitated by an institutional mechanism that we call *information processing*. The LCCP teams performed due diligence on each of the potential Chinese partners, and a more in-depth and tailored investigation of the partner eventually selected by each UK SME. While the initial due diligence covered basic aspects, such as the formal existence of the organization and its registration number, the more in-depth information typically involved the LCCP China team re-discussing the potential partnership terms with the Chinese organization in question, and a further assessment and verification of their stated contribution to the partnership. This information acted as a risk mitigator for the UK SMEs that would otherwise have had to make a decision without such information or procure it themselves at greater expense.

Part of the information collected and processed was then used to start formalizing the partnership in a contract. As prior studies show, a legal framework, such as a contract template, reduces negotiation time and effort (Tripsas et al., 1995). LCCP engaged lawyers with experience in China to provide workshops to help the UK SMEs understand China's legal framework, such as IP protection and clauses to pay attention to in drafting the contract. The LCCP team also provided UK SMEs in discussion with Chinese partners a bilingual heads of terms template to guide the agreement drafting process. Although the template did not present legal constraints, it offered *legal guidance* for the partnership under formation and constituted an effective institutional mechanism on which the partners could rely to speed up the negotiation process.

Furthermore, in this stage, LCCP provided the UK SMEs advice and information on the overall environment in China. Most of the SMEs had little or very little experience with China, and none had knowledge of the Chinese language. The discussions with Chinese partners were aided by interpreters that LCCP provided, helping the UK SMEs better identify the risks involved and the resources needed without translation costs and reducing the negotiation costs. We call this first administrative mechanism *cross-border mediation*. LCCP's role went beyond language support, including cultural interpretation and acquiring additional intelligence on the selected Chinese organizations on behalf of the UK SMEs, advising them on partner selection and agreement development.

4.3. Development

After the partners agreed to work together, they had to define and agree the details and specifications of the new product/service to be developed to submit the GDST funding application, as well as develop the project brief for students to continue the project in China. While the LCCP teams continued providing *legal guidance* on contract negotiation, this stage was a turning point for many of the developing partnerships. Firms E, F, G, and H received funding and proceeded to the next stage. Applications by Firms D, I, and J failed, but the partners decided to remain in touch to pursue future opportunities. Firms A, C, and K interrupted their relationship as a result of their failed GDST funding application.

From an institutional point of view, both funding streams provided a *legal framework* that reduced the negotiation space between the partners, in turn reducing the associated costs. While this legal mechanism was more in terms of guidance than a strict protocol on the UK side (UK SMEs were provided with tailored templates for UK-China R&D agreements), the Chinese funding stream required partners to fill out a detailed and rigorous set of documents outlining their agreement. This then became the legal framework that bound the partners in working towards a common goal. However, the funding call was entirely in Chinese, and the funding

application needed to be completed in Chinese. This left UK SMEs at a disadvantage, as their view of the funding application was filtered by their Chinese partner. It is at this stage that the presence or absence of administrative mechanisms affected TCs by mitigating or enhancing information asymmetry and opportunistic behavior. In other words, the institutional mechanism providing a legal framework on the Chinese side only works if monitored and enforced when the funding has been granted and the project is being developed in the continuation stage.

The *cross-border mediation* administrative mechanism identified in the formation stage continued and intensified in the development stage. Here it entailed tailored support for interpretation to aid negotiation while developing a contractual agreement and the funding application. Each UK partnering SME was allocated to a LCCP China team project manager who coordinated and supervised the GDST funding application.

Furthermore, UK SMEs benefitted from a *training and experience sharing* administrative mechanism. With the UK funding, the UK LCCP team conducted training throughout the program in this stage on key aspects of doing business in China (including drafting the template agreement). Increased knowledge of the business environment in which they would operate helped speed up the partnering process and reduced exposure to opportunistic behavior on the Chinese side. Furthermore, sharing and discussing their experience with the other UK SMEs in the program was an exercise in peer learning that contributed to their ability to reduce the costs associated with the negotiation and execution of contracts.

4.4. Continuation

After successfully applying for and receiving funding from GDST, 4 UK-China partnerships (Firms E, F, G, and H) entered the continuation stage by undertaking their R&D projects. An additional UK-China partnership developed by Firm B did not apply for funding and continued the R&D collaboration independently. TCs in this phase arose mostly from the need for

frequent interactions between the partners to conduct the project and monitor progress according to the agreed timeline and contributions.

In this stage, we identified two mechanisms. The first is an institutional mechanism consisting of the reporting requirements imposed by the UK funding body on UK SMEs to ensure accountability throughout and the commitment requirement from GDST funding imposed on Chinese partners to match funding. While this *progress reporting and resource commitment* mechanism did not decrease information asymmetry, it reduced the incentive to behave opportunistically. The government umbrella under which partnerships are formed offers a guided pathway for UK-China partnerships that jointly commit resources, both monetary and non-monetary, to pursue common goals following the LCCP timeline.

Next, an administrative mechanism – *student monitoring* – implemented by the UK funding stream required bi-weekly reports from students and enabled the LCCP teams to provide project advice. Based in the UK and with limited resources, UK SMEs struggled in working with their Chinese partner, and more importantly, had issues understanding the progress made on their side. The students' role helped reduce information asymmetry, as they assisted UK SMEs in bridging the information gap with their Chinese partners. The students' work was monitored by the LCCP team and the respective LU schools as the academic component. The support provided through the funded LCCP teams – especially the China-based team – helped overcome some of the challenges and reduced some of the costs associated with travelling or spending time interacting with their partners. Instead, they could ask their LCCP project manager to update them on the progress or intervene to help unblock bottlenecks. More importantly, this mechanism entailed the provision of a team of students to each partnership.

Despite the institutional mechanism that surrounded the partnerships born under the government umbrella, the GDST funding lacked an administrative mechanism that ensured the enforcement of the funding reporting requirements, thus increasing the potential for

opportunistic behavior. Indeed, three of the four UK SMEs were subjected to some form of opportunistic behavior from their Chinese partners. While Firm E had to make recourse to invoicing the Chinese partners to compensate their loss in developing technological solutions, Firm F found out only at the end of the project that their partner – a research organization with less incentive to develop a commercial result – did not deliver what was expected, despite benefitting from the full GDST funding.

> *"The GDST funding terms specified that none of the granted money could be spent outside of China, and eventually we had to find a work-around to be able to invoice our partner for some consulting fees to try and recoup at least some of our investment."* (Firm E)

> *"The partner organization got the GDST funding, so they didn't really have anything to lose… They really delivered nothing and we can only assume their objectives were not aligned with our own."* (Firm F)

These behaviors were mostly due to the fact that the administration and management of the GDST fund awarded was entirely in the hands of the Chinese partners. The UK SMEs had very limited visibility of the fund distribution: how it was managed, spent, and officially reported. This led to the extreme situation of Firm G, which completely lost contact with its partner soon after the fund was awarded.

> *"The partner we had, I don't know what happened there. They got all the money and did some stuff with it… And we have heard nothing from them ever since."* (Firm G)

In summary, as Figure 2 shows, both the UK and Chinese funding streams implemented institutional mechanisms in both the *ex-ante* and *ex-post* phases, and through this managed to reduce opportunistic behavior. However, a mostly opposite effect manifested through their administrative mechanisms in the *ex-post* phase. While the UK funding stream's administrative mechanisms had a positive effect on the risk of opportunistic behavior through reducing

information asymmetry, the Chinese government did not make recourse to such mechanisms in the *ex-post* phase, leading to a higher risk of opportunistic behavior.

(Table 3 about here)

5. Discussion

Although the UK and Chinese funding intended to operate almost jointly, their *modus operandi* and mechanisms to facilitate and monitor the R&D collaboration process differed greatly. This was mostly due to a difference in the way the funding was administered, resulting in mixed effects of the administrative mechanisms as described in the previous section and depicted in Figure 3.

(Insert Figure 3 about here)

While LU employed both institutional and administrative mechanisms in managing the fund, the latter were certainly the prevalent mode through which it (attempted to) minimize TCs for the participating SMEs. In fact, while the program provided a framework or pathway for SMEs to follow, this mainly had the function of dictating the agenda that participating firms adhered to, providing legal guidance rather than a legal framework.

The active role that the program team members played in the UK and China was instead a strong administrative mechanism through which the program positively impacted the information disadvantage that UK SMEs suffered from in navigating a relatively unknown business environment. Similarly, the university students constituted another administrative mechanism in the *ex-post* phase, also as a means to reduce the knowledge gap between the partners. The co-occurrence of institutional and administrative mechanisms in both the *ex-ante* and *ex-post* phases advances our understanding of the government's role in supporting R&D partnerships by reducing TCs. Indeed, prior studies (e.g. Tripsas et al., 1995; Okamuro and Nishimura, 2015) suggest reliance on institutional and administrative mechanisms in the *ex-*

ante and *ex-post* phases respectively.

Conversely, the approach that the local Chinese government took mostly relied on institutional mechanisms. Through the bidding funding platform, the government provided a clear set of rules that enabled organizations to participate (e.g. high-tech companies in a specific Chinese region), the participation requirements (e.g. having an international partner), and documentation (e.g. project plan, budget, intellectual property agreement with foreign partner).

While the availability of funding to help foster international R&D collaborations should in principle have a positive impact (Hottenrott and Lopes-Bento, 2014), we found that in this case, it did not reduce information asymmetry or uncertainty for the UK SMEs that intended to collaborate with Chinese partners. On the contrary, it seemed to allow the Chinese organizations to leverage the transactional characteristics to strengthen their position with the UK partners. We found that the availability of funding without appropriate administrative mechanisms only helped in creating partnerships in the *ex-ante* phase, and had a negative impact on development in the *ex-post* phase.

The Chinese government and LU institutional framework was perceived by the UK SMEs as reducing the risk of opportunism and were therefore encouraged to sign the agreements that sped up the establishment of the partnerships. This was contrasted in the *ex-post* phase with the lack of monitoring and control mechanisms implemented by either the UK or Chinese side, thus making the agreements void. Benefits deriving from formalization driven by an institutional mechanism in the *ex-ante* stages are not realizable unless appropriate monitoring and enforcing mechanisms are put in place in the *ex-post* phase, especially considering that one of the main drivers for SMEs to establish R&D partnerships is access to public funding (Arranz et al., 2016).

Most studies on the impact of public support on R&D or collaborative R&D projects use

monetary measures, most commonly R&D subsidies or R&D tax relief (Czarnitzki et al., 2007). By switching the focus from this to the way government funding is administered, we unveil a dark side of public support for R&D partnerships. Our study shows that public funding made available through the described mechanism can act as a hindrance to the development of international R&D partnerships. In fact, the way the Chinese funding was managed and organized dramatically increased the risk of opportunistic behavior by the Chinese partners. This was the case despite the institutional framework and the high level of formalization of the funding process. The element of discrimination was language and the fact that only one partner could lead the funding application. We argue that this could be the case for most international R&D partnerships that are publicly funded only by one side.

6. Conclusion

Adopting a TC approach, this study offers a more refined view of the impact of government funding on the international R&D partnership lifecycle, contributing to the literature in multiple ways. From an empirical and methodological viewpoint, diverging from existing research that has largely examined the positive effects of government funding on collaborative R&D projects by measuring their outcomes (Bellucci et al., 2019; Radicic et al., 2020), this paper adopts a process view that allows us to outline, even though with limitations, such effects at different stages of forming a collaborative R&D projects. Second, by offering an international view, in comparison to studies that have thus far mostly focused on the European scenario (Broekel et al., 2015), this study reveals how asymmetry of information can lead to opportunistic behaviors in an international R&D partnership in a different context. By incorporating an international dimension, we offer a novel view of the higher risk of opportunism in interdependent public funding schemes.

From a theoretical perspective, we believe the model emerging from this study contributes to the TCE literature by providing a more refined understanding of the role of government

funding in mitigating opportunistic behavior based on breaking down the R&D alliance process, the TCs associated with each stage, and the mechanisms likely to reduce these TCs. In so doing, we offer insights that may be utilized in future scholarly investigations of sub-optimal international government funding schemes. Building on the work of Tripsas et al. (1995), we support the notion of a more holistic role of government in facilitating collaborative R&D, but depart from their conceptualization and those of other studies (e.g. Okamuro and Nishimura, 2011) inasmuch as they consider a government's funding role as separate or alternative to reducing opportunistic behaviors.

In particular, we identify three main theoretical contributions. First, while the TCE literature largely assumes government funding to have a positive effect on mitigating TCs in R&D partnerships, we depart from this view by showing that government funding can act as a double-edged sword which can also have a negative effect on TCs by creating potential for increased opportunistic behavior. Thus, we invite researchers to examine further from the perspective of bounded rationality and information asymmetry among collaborators the way in which public funding is administered to facilitate collaborative R&D, which can be a means to both reduce and increase opportunistic behavior. We believe this challenges the *status quo* and will hopefully stimulate future research.

Second, while most of the literature has looked at the outcomes derived from monetary mechanisms of government funding or R&D partnerships, our study has examined both monetary and non-monetary mechanisms. It therefore provides a more nuanced view of how government can support the creation and nurturing of R&D alliances by establishing *ad hoc* regulatory frameworks and collaborative environments. We thus encourage scholars to consider different dimensions of government funding and what roles these mechanisms play in the *ex-ante* and *ex-post* stages in facilitating international R&D partnership formation and development.

Third, in contrast to most previous studies that look at a single government funding scheme, our paper considers a government-run scheme supported by two different funding streams. In doing so we offer a view on the interplay between the two schemes and how mechanisms established by one scheme to mitigate opportunistic behavior can be nullified by the lack of proper mechanisms in the other scheme. This calls for more research on programs receiving more than one funding streams to provide more evidence on the interplay between different streams in an attempt to mitigate opportunistic behavior.

In as much in providing a process view, our study only relies on a unique case in a specific context and our findings may not apply (or apply differently) to other schemes. Support programs such as the UK-China Research and Innovation Partnership Fund under the Newton Fund or the EU-China Co-Funding Mechanism both aim at fostering R&D collaborations between European countries and China based on reciprocity of monetary mechanisms rather than non-monetary ones. What we discovered may not hold true for these schemes or for other support programs. We would therefore encourage scholars to carry out cross-schemes studies to add more insights into how government funding programs can contribute to sustaining R&D collaborations.

For managers, this study suggests that not all funding has a positive effect when collaborating with external organizations, and bounded rationality may inhibit managers in choosing the most suitable funding program to support the collaboration. On the one hand, government funding can provide an important, and sometimes essential, means to exploring new developments. Businesses, especially SMEs, are then encouraged to embark on similar support programs to access complimentary resources or raise their international profile (Bianchi et al., 2011). On the other hand, the mode through which such funding is administered can have a negative impact, especially if funding is linked to establishing partnerships with foreign organizations.

Similarly, for policymakers, this study cautions them to consider different critical elements when designing support schemes for SMEs. While monetary mechanisms to support R&D collaboration remain of essential importance, we encourage policymakers to give further consideration to non-monetary ones. In particular, our study suggests that the way in which funding is administered plays an important role in determining the establishment and survival of R&D partnerships. Furthermore, based on our specific case of a combination of two coordinated funding schemes, we suggest that synergies and contrasting effects between the two administrations should be thoroughly considered before implementation. Specifically, the co-presence of the monetary and non-monetary nature of different elements of the supporting schemes seems to open to the risk of increased opportunistic behavior and should therefore be carefully considered before implementing a dual funding scheme.

Finally, this study has a number of limitations. While the case study approach revealed dynamics not identified in previous research, our findings can only be generalized analytically (Yin, 2017), not statistically. Additionally, the Chinese context, even though interesting and relevant, is an exceptionally complex scenario for UK SMEs given the geographic and cultural distance, as well as the substantially different business systems. We expect similar studies in countries with greater proximity will reach different conclusions. In addition, we encourage future scholars to study how differences in SME governance (e.g. family vs. non-family SMEs) might play a role in international R&D partnerships, as prior research has argued that collaborative innovation follows unique dynamics in family firms (Feranita et al., 2017).

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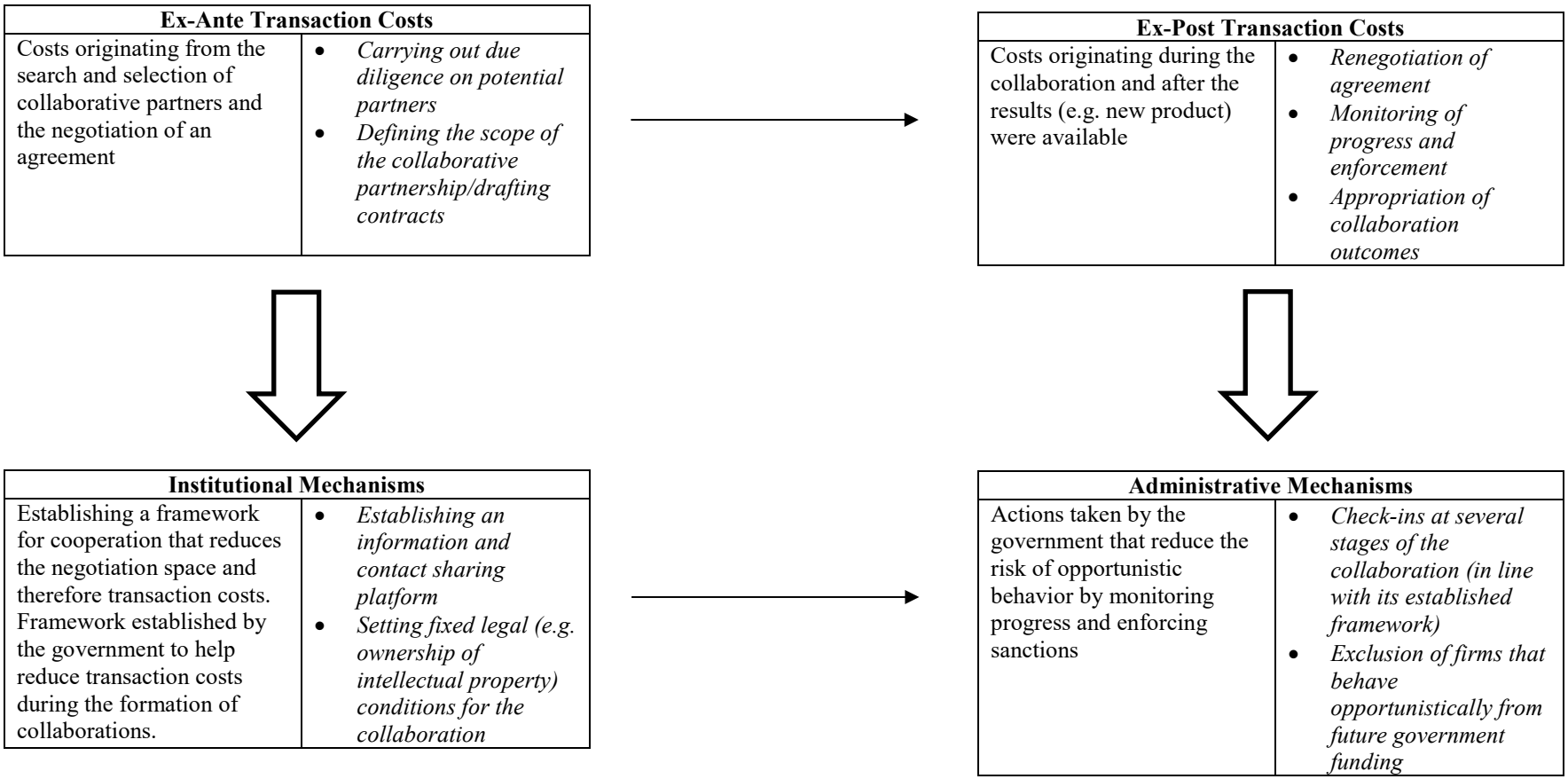

Figure 1. Transaction costs and government mechanisms to reduce them. Authors' elaboration of Williamson (1985), Tripas et al. (1995), and Dahlman (1979)

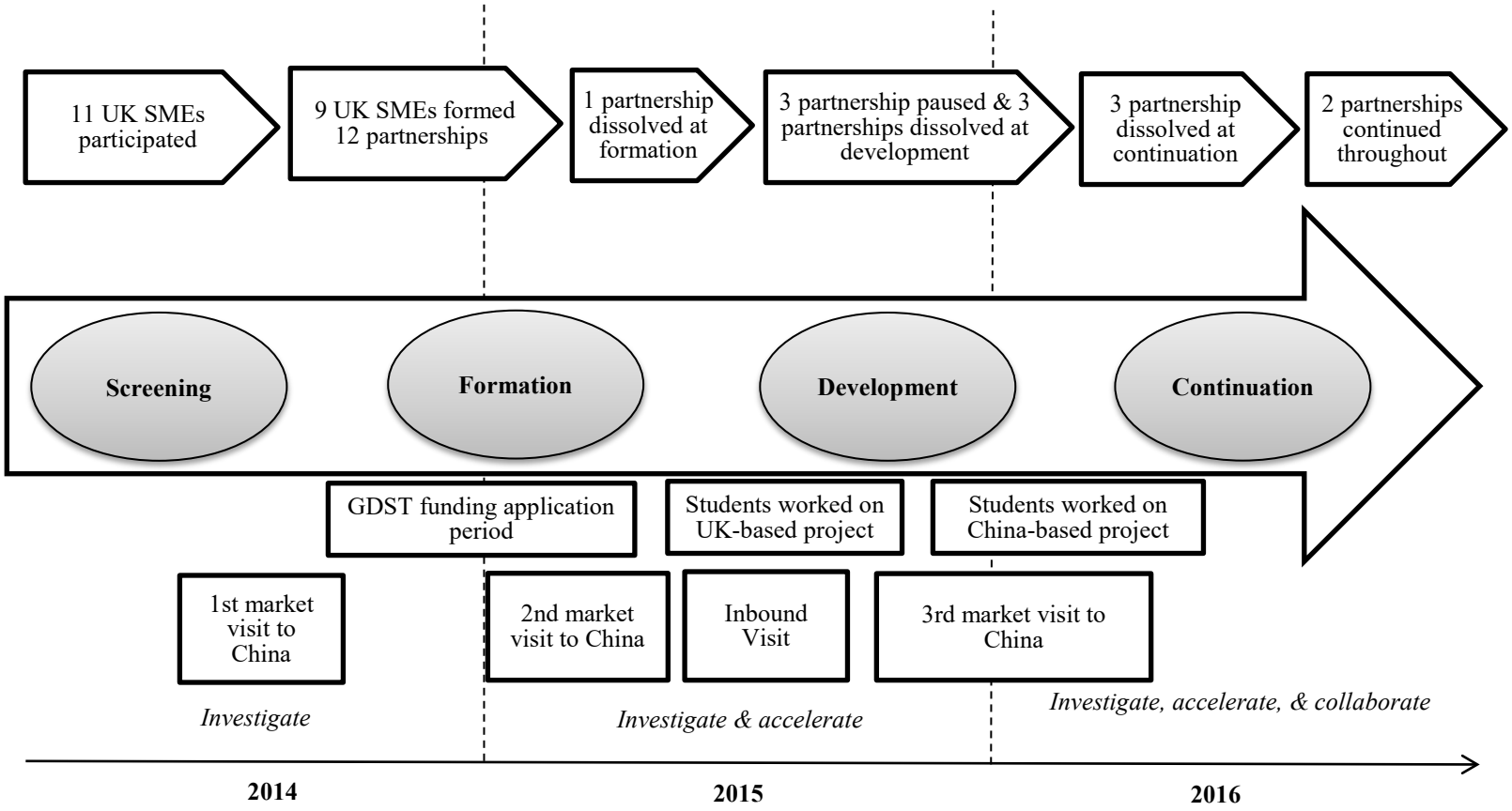

Figure 2. Timeline of the UK SMEs' journey during LCCP

UK FUNDING
CHINESE FUNDING
ADMINISTRATIVE MECHANISMS
INSTITUTIONAL MECHANISMS
Screening
EX-ANTE
Formation
Development
EX-POST
Continuation
INSTITUTIONAL MECHANISMS
ADMINISTRATIVE MECHANISMS
(LACK OF) ADMINISTRATIVE MECHANISMS

Case	Industry	Firm size (no. of employees)	Prior/existing connection to China?	Developed partnership?	Chinese Partner	Aim of the partnership	Applied for GDST funding?	GDST funded?	Partnership status
Firm A	Agricultural and environmental consultancy	450	N	Y	Data mining and data processing medium-sized enterprise	Development of agricultural decision support tools for the Chinese market based on Firm A's product portfolio and its partner's knowledge of the Chinese market and data management capability	Y	N	Dissolved at *development* following an unsuccessful GDST funding application.
Firm B	Solar energy	73	Y	Y	Medium-sized private enterprise specializing in the design and manufacture of solar lighting systems	Development of a remotely monitored and controlled off-grid solar system to electrify homes, offices, schools, and other buildings in the developing world, primarily Africa	N	N	Continued throughout
Firm C	Dairy industry	9	N	N	Small enterprise developing IoT solutions to monitor farming supply chains and products	Development of software and app to trace dairy product international supply chains, especially between the UK and China	N	N	Dissolved at *formation* before submitting the GDST funding application
Firm D	Advanced engineering	23	Y	Y	Engineering research department of local university	Identification and testing of applications for additive manufacturing of high-end filters by selective laser melting for global markets	Y	N	Paused at *development* after unsuccessful GDST funding application
Firm E	Automation hardware and software	4	N	Y	Large globally-oriented private enterprise providing smart solutions for homes, buildings, and hotels	Development of an innovative app for IOS devices to simplify the installation process of the Chinese partner's solutions	Y	N	Dissolved at *development* after unsuccessful GDST funding application.
				Y	Medium-sized university-based private enterprise developer and manufacturer of LED lights	Development of software and app for intelligent lighting products designed by the Chinese partner	Y	Y	Dissolved at *continuation* following project completion.
Firm F	Consumer Electronics	14	Y	Y	Public software development and application research institute	Intelligent video surveillance, data mining, analysis, and decision making system based on cloud technology for smart home and community applications	Y	Y	Dissolved at end of *continuation* after unsatisfactory project outcome.

Firm G	Automotive	15	N	Y	Public research institute on industrial technology	Design and prototype development of carbon composite brake discs	Y	Y	Dissolved at beginning of *continuation*
Firm H	Career development service	2	Y	Y	Mid-sized private enterprise focusing on the development and sales of digital campus and cloud-based education platform solutions	Development and launch of a UK-based online career development learning system	Y	Y	Continued throughout
Firm I	Multi-disciplinary consulting	60	Y	Y	Medium-sized private enterprise specialized in engineering and consulting services for waste treatment and soil restoration	Development of a demonstration plasma gasification plant to convert mixed waste to energy	Y	N	Paused at *development* after unsuccessful GDST funding application.
Firm J	Environmental and energy consultancy	36	Y	Y	Medium-sized private enterprise developing technological solutions in digital water conservancy, smart grid, smart city, and automation systems engineering	Development of remote operated water analysis devices, incorporating cloud data storage, helping to monitor water-system quality	Y	N	Dissolved at *development* after unsuccessful GDST funding application.
				Y	Consortium of three small enterprises in water and air quality industry	Integration of Firm J's real time water monitoring device with China-based forecasting modelling provided by Chinese partners	Y	N	Paused at *development* after unsuccessful GDST funding application
Firm K	Chemical consultancy	15	Y	Y	Medium-sized subsidiary of large state-owned conglomerate in the energy sector	Development of service solutions to ensure industry compliance with global chemicals regulations and support the implementation of best practices in manufacturing supply chains	N	N	Dissolved at *formation* due to complexity of GDST funding application for Chinese partner

Table 1. Focal UK SMEs and partnership status.

	Screening	Formation	Development	Continuation
Institutional	Original funding bid for HEFCE Minutes of Project Delivery Group Meetings HEFCE Progress Reports Interim Independent Evaluation Report (May 2016 – inclusive of survey to firms and students) Final Independent Evaluation Report (Feb 2018 – inclusive of survey to firms and students) GDST funding internal documents – aims & scope, application guidelines, progress report			
Firm & Project	• Sign-up docs (inclusive of company profile, China's strategy and potential partner profile) • List and dates of meetings with potential Chinese partners • Feedback on the above meetings	• Feedback on the selected partner • Rationale behind choice of partner based on field notes • Cooperation agreement (if applicable)	• GDST funding application (if applicable) • Cooperation agreements (if applicable) • Field notes based on regular meetings with UK SMEs on partnership updates	• Students' project briefs and proposals (UK and China) • Field notes based on regular meetings with UK SMEs on partnership updates
	In-depth interviews Dates and agenda of China visits for each company Field notes throughout the company's journey during the program based on regular update meetings			
Student			• Students' allocation to company projects based on their background • Students' project briefs (UK and China)	• Students' project briefs and proposals (UK and China) • Students' interim presentations (including PPTs and field notes – UK and China) • Students' final report (UK and China)

Table 1. Data sources for each phase

	Mechanism	Description	Case in point
Screening	***Institutional Mechanisms***		
	Contact and Network Sourcing Platform (UK & China)	LCCP China and UK teams worked together in matching UK SMEs' criteria with potential Chinese partners through accessing Chinese databases and LU's network in China. The opportunity to rely on such platform reduced search costs for participating firms.	7 out of the 11 UK SMEs had some prior connection with China, but they were not able to materialize these into R&D partnership, as they lacked the searching and screening resources. Firm F was in such position when it engaged with LCCP. Having previously worked in China, their experience was mostly with suppliers and not R&D partnerships. Relying on LCCP was considered less risky and cheaper than looking for a partner by themselves: *"For me, do I do it by myself? Or do I work with LCCP with its knowledge and understanding of what's required to develop products, have Chinese partners and alliances? For me it's quite simple, doing on my own, high risk; doing it with LCCP, with the support that goes with it, minimizes my risk, have much better opportunities to develop links and networks, and that's exactly how it happened. Would I have met our partner had I not participated in LCCP? Of course not"* (Firm F) Being a service-oriented SME, Firm J always sought to build relationships over time instead of striking a deal, thus it was simply too expensive to have a constant presence in China to search for the right partner: *"I think it [arranging B2B meetings] becomes very complicated by yourself. You find people but the efficiency of the matchmaking process that we had… you couldn't create that efficiency by yourself"* (Firm J)
Formation	***Institutional Mechanisms***		
	Information Processing (UK & China)	The LCCP China and UK teams performed due diligence on potential Chinese partners and provided further assessments of the intended partnership. In so doing, they significantly reduced the costs of searching and processing information for participating firms.	Given their size and limited resources, the UK SMEs would have taken longer and incurred more costs for further verification and assessment of the potential Chinese partner. Despite having worked in China for the past few years, Firm H was not able to find a trusted collaborator to take the idea forward, and as a small business, could not run due diligence nor verify the information they were providing: *"It was a big bonus that the program could find a partner so quickly and assist with the due diligence and support for early meetings, as we had not been in a position to do so previously"* (Firm H)

	Legal Guidance (UK & China)	The LCCP UK and China teams worked with experienced lawyers in guiding UK SMEs in the negotiation while formalizing the partnership with the Chinese partners. Specifically, a Heads of Terms template was developed and made available to UK SMEs that needed to develop an agreement with Chinese partners. Furthermore, training by lawyers who developed the template was provided to participating firms. This significantly reduced the negotiation space, time, and in turn, costs.	Lacking knowledge and confidence in doing business in China, UK SMEs traditionally faced significant learning and contractual costs. Participating firms were particularly worried about Intellectual Property (IP) protection and the risk of their Chinese partner leveraging information asymmetry to exploit them. Legal guidance helped Firm G, which had no prior experience with China, overcome this challenge: *"The training from the LCCP has been particularly useful I would say. Without the training from LCCP I don't think we would have gone to China, I think we would have taken a much more traditional scared view of IP protection on the country as a whole and we wouldn't have gone I think. I think it is only because of the LCCP training that we've had the whole courage and the confidence to approach China actually"* (Firm G) Even firms with previous experience with China recognized that in the absence of legal guidance, it would have taken longer to develop an agreement: *"We are doing the partnership agreement, thanks to the write-up provided by LCCP that was quite useful, because we are using the heads as a basis"* (Firm F)
	Administrative Mechanisms		
	Cross-Border Mediation (UK & China)	LCCP teams conducted workshops that helped UK SMEs to understand the Chinese culture, and translators were provided during both inbound and outbound visits to facilitate communication between UK SMEs and the Chinese partners. This reduced both risks and costs associated with negotiation with Chinese partners.	Navigating a relatively unknown but very different cultural environment posed UK SMEs the risk of being taken advantage of by their Chinese counterparts who could leverage information asymmetry. While this can be mitigated by interpreters or mediators, the associated costs are high. Having this mediation government-funded helped SMEs like Firm J overcome this barrier and develop a partnership agreement: *"The program takes all of that [cultural and language barriers in doing due diligence] away … So if you're going to meetings with interpreters, not only is the interpreter there to do the language part but also helps with the information intelligence part"* (Firm J)
Development	***Institutional Mechanisms***		
	Legal Guidance (UK)	The LCCP teams worked alongside UK SMEs providing guidance on contract negotiation and project brief development for students to continue the project in China. Guidance on GDST funding application was also provided and an *ad hoc* template R&D agreement, supported by additional	Partnerships interested in applying for GDST funding had to develop a detailed R&D agreement. The relatively scarce knowledge that UK SMEs have of the Chinese business environment exposed them to high risk of opportunistic behavior by their Chinese partners. The template R&D agreement and knowledge and support provided by LCCP helped them reduce this risk as well as the costs associated with developing an agreement: *"With the Chinese legal system, we didn't really understand what we were getting into and we learned a lot from the training. It gave us at least the confidence to give it a go. If we hadn't had that, I think we would have just run away and hidden"* (Firm G)

		legal training, was made available to participating firms. Similar to the formation stage, this mechanism reduced the space, time, and costs associated with the negotiation and drafting of agreements.	
	Legal Framework (China)	GDST funding required each partnership to submit a rigorous proposal detailing technical specifications, resource allocation, and a commercialization plan. This was based on an official form provided by the Chinese Government, hence similar to but stricter than the legal guidance mechanism, offering reduced space, time, and costs associated with drafting an agreement. Furthermore, the work required on the Chinese side to develop this proposal reduced the risk of their opportunistic behavior, as they would commit resources to the partnership.	Some partnerships dissolved due to the need to develop the required detailed proposal. This legal framework thus acted as a mechanism to filter out opportunistic partners. For example, Firm K's partner disappeared after realizing the resources to commit to the development of the proposal: *"What actually matters is GDST saying that 'we would like to look into this project and we want to support it'. It is important because now GDST is backing us with this, we better deliver it, otherwise we are gonna look stupid. So, it's not the money, it's the mixture of support and pressure that the GDST involvement creates"* (Firm H) On the opposite side, Firm H's continuation of the project was possible due to the funding framework established by the Chinese government: *"Working on GDST funding, through the institute, hence adds credibility in China and helps build the relationship in the future"* (Firm G)
	Administrative Mechanisms		
	Cross-Border Mediation (UK)	Continued support from LCCP teams in overcoming language and cultural barriers to facilitate partnership development between UK SMEs and Chinese partners.	Support from the program, and especially from the China team, enabled SMEs to maintain an active continued relationship with their partners from a distance. For example, Firms D, F, and H established a routine where a LCCP China-based project manager would attend and facilitate regular calls between them and their Chinese partners from their partners' offices. This significantly reduced the risk of opportunistic behavior as a consequence of more information being available (at a reduced cost) to the UK SME: *"I don't think what we are doing would have got this far so quick without LCCP. I really don't, because I've been trying to do this for the past few years. We did get some support from other trade mission program[…] but LCCP has taken the whole thing to a different level because of […]the fact that you've got Chinese government support, British government support, the university underpinning the whole thing with staff and resources, the students, and help on exchanging, physically going from one country to the other and vice versa"* (Firm H)

	Training and Experience Sharing (UK)	The LCCP UK team conducted workshops on further enhancing UK SMEs' knowledge on doing business in China. Experience sharing and peer learning were achieved through visits to China and networking sessions facilitated by the LCCP team. Peer learning was particularly useful in preventing or solving issues due to information asymmetry.	Travelling to China to meet partners as part of a cohort helped firms such as I and J gain more confidence as issues arising could be discussed with peers straight away and therefore save the costs of seeking answers elsewhere or being unprepared for potentially opportunistic behavior based on information asymmetry: *"I really like the support in visits, it's a group going out so it's joint learning, as opposed to going alone, you will feel more exposed"* (Firm I) *"There was a wealth of knowledge and experience within the program network. The other companies were able to explain common issues they had while doing business in China"* (Firm J)
Continuation	***Institutional Mechanisms***		
	Progress Reporting and Resource Commitment (UK & China)	Both UK funding and GDST funding required participating firms to commit both monetary and non-monetary resources in return.	The geographic distance and other barriers made UK SMEs wary of the project progress, but the monetary commitment from Chinese partners through match funding gave UK SMEs an extra layer of assurance that the project would be undertaken. This was clear in the case of Firm H. If their partnership had not been under an established framework funded by the government, Firm H would have had no means to ensure continued commitment from the Chinese partner: *"Financially, the GDST funding has no impact directly. The money goes to our partner… The mixture of support and pressure from GDST funding is valuable to keep things moving and make the project work"* (Firm H)
	Administrative Mechanisms		
	Student Monitoring (UK)	Students working with partnering Chinese organizations in China were to report back bi-weekly, acting as a bridge between UK SMEs and Chinese partners.	Without the support from GDST, UK SMEs would have to travel more frequently to China to monitor the project progress, incurring money and time costs, and to the detriment of other ongoing projects in the UK. In Firm I, students provided by LCCP ensured that progress was monitored. In turn, Chinese partners were more responsive and active on the project as well as less opportunistic, as information asymmetry was reduced: *"Now the students are there, that's really again quite a huge focus for frequent dialogue which for me has given me a lot of confidence in the relationship and how serious they are taking it"* (Firm I)

Table 3. LCCP mechanisms